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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|-----------------|-------------|----------------------|---------------------|------------------|
|-----------------|-------------|----------------------|---------------------|------------------|

10/666,671

09/17/2003

Hongqin Shi

TI-62961

8251

23494

7590

06/10/2009

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EXAMINER

VINH, LAN

ART UNIT

PAPER NUMBER

1792

NOTIFICATION DATE

DELIVERY MODE

06/10/2009

ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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| | | | |
|------------------------------|--------------------------------------|-----------------------------------|--|
| Office Action Summary | Application No. 10/666,671 | Applicant(s) SHI ET AL. | |
| | Examiner LAN VINH | Art Unit 1792 | |

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 23 February 2009.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-3, 5-21, 24-29, 63, 64, 66-71 and 81-83 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☒ Claim(s) 81-83 is/are allowed.
- 6) ☒ Claim(s) 1-2, 5-21, 26-29, 63, 64, 66-71 is/are rejected.
- 7) ☒ Claim(s) 3, 24 and 25 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Response to Arguments

1. Applicant's arguments filed 2/23/2009 have been fully considered but they are not persuasive.

The applicants argue that the Examiner is mischaracterizing Donohue for serving as an evidence that the feeding time is a result effective variable because Donohue appears to merely teach pulsing an etch gas to achieve two different conditions.(fig. 17). This argument is unpersuasive because while it is true that fig.17 of Donohue appears to merely teach pulsing an etch gas to achieve two different conditions, it is also true that fig.17 also show that the time/feeding time varies as the flow rate changes (i.e . the time varies from 85 seconds to 100 seconds as the flow rate of CHF3 increases from 25 sccm to 30 sccm). It is maintained that Donohue serves as an evidence that the feeding time is a result effective variable

The applicants also argue that Sedigh appears to teach away from endpoint detection systems and instead advocates the determination of etch process durations based on the pre-etch measurement of physical dimensions and reliance on historical data from etching other similar substrates. This argument is unpersuasive because Sedigh clearly discloses in col 9, lines 1-5 that:

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In one example, optical emission spectroscopy endpoint detection systems monitor the optical components of the plasma generated by the etch chemistry during an etch process. Some of the optical components, such as wavelength of light, are specific to the material being etched. Thus, by monitoring a wavelength of light, which is specific

It is maintained that Sedigh does not teach away from endpoint detection systems

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The applicants further argue that Sedigh teaches the use of pre-etch values to determine some of the etch process parameters, not "adapting said second etching process based on monitoring said parameter during said second etch process" as recited by amended Claim 63. This argument is unpersuasive because as described in col 5, lines 45-49, col 24, lines 24-43, fig. 9, Sedigh discloses etching a subsequent topography/second microstructure in a second etching process using the etchant recipe based on the collected data of the parameter in the first etching process and adapting said second etching process based on monitoring said parameter during said second etch process.

Double Patenting

2. Claims 3, 24-25 objected to under 37 CFR 1.75 as being a substantial duplicate of claims 81, 82-83. When two claims in an application are duplicates or else are so close in content that they both cover the same thing, despite a slight difference in wording, it is proper after allowing one claim to object to the other as being a substantial duplicate of the allowed claim. See MPEP § 706.03(k).

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1-2, 5-6, 10-12, 15, 17, 26-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Buskirk et al (US 2002/0011463 A1) in view of Donohue et al (US 6,784,108) and further in view of Sedigh et al (US 6,893,974)

Buskirk discloses a dry cleaning process. The process comprises the steps of: loading a microelectronic device/microstructure into an etch chamber of the etch system, wherein the sample comprises silicon/sacrificial material and a platinum layer/ structural materials (page 2, paragraph 0020, paragraph 0033, 0035) providing a etchant recipe comprising XeF₂ vapor to etch the silicon/sacrificial layer (page 2, paragraph 0019, 0020) measuring an amount of a etchant/chemical species in the process (page 2, paragraph (page 2, paragraph 0036)

determining the time and condition for the reactive halide etch and empirically determining the nature of the etching while varying the time and contacting conditions such as concentration of the etching agent to identify the process condition (page 3, paragraph 0039), which reads on determining a etching time based on the measurement and further etching the sacrificial material by providing an additional amount of the spontaneous vapor phase etchant recipe to the etch system based on the determined etching time to continue the etch process

Unlike the instant claimed invention as per claim 1, Buskirk does not specifically disclose determining a feeding time based on the measurement of the amount of a chemical species/etchants

Donohue discloses a etch profile control method comprises a step of determining a feeding time based on the measurement of the amount of a chemical species/etchants

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(col 10, lines 49-54; fig. 17). Donohue serves as an evidence that the feeding time is a result effective variable

Thus, one skilled in the art at the time the invention was made would have found it obvious to determine any feeding time, by conducting routine experimentation, based on the measurement of the amount of a chemical species/etchants in Buskirk method in view of Donohue teaching since it has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. In regarding claim Boesch, 617 F.2d, 272,205 USPQ 215 (CCPA 1980)

Buskirk also fails to disclose detecting an amount of chemical species flowing out of the etch chamber resulting from etching of the sacrificial material from the present spontaneous vapor phase etchant recipe

Sedigh discloses collecting data/parameter/chemical species from a first etching process, determining deviations from the data analyzed in the first etching process and adjusting the process conditions/parameter/chemical species for subsequent substrates based on the data obtained and analyzed in the previous etching process (col 9, lines 1-27, col 11, lines 17-34)

One skilled in the art at the time the invention was made would have found it obvious to modify Buskirk method to include a step of detecting an amount of chemical species flowing out of the etch chamber resulting from etching of the sacrificial material from the present spontaneous vapor phase etchant recipe in view of Sedigh teaching since Sedigh discloses that using feed forward control of the etch process parameter/etchant/chemical species advantageously fabricates openings having profiles and

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dimensions, which exhibit little to no deviation from a design specification (see abstract)

The limitation of claims 2, 5-6, 26-27 have been discussed above

Regarding claims 10-11, Buskirk discloses that the etchant comprises an inert/diluent gas (page 3, paragraph 0043)

Regarding claim 15, Buskirk discloses performing process in cycles (page 1, paragraph 0016), which reads on repeating the steps of the process

Regarding claim 17, Bskitk discloses that the etchant has a pressure of 50 mTorr-2 Torr (page 2, paragraph 0035)

3. Claims 7-8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Buskirk et al (US 2002/0011463 A1) in view of Donohue et al (US 6,784,108) and Sedigh et al (US 6,893,974) and further in view of Tai et al (US 6,436,229)

Buskirk as modified by Donohue and Sedigh has been described above. Unlike the instant claimed invention as per claims 7-8, Buskirk, Donohue and Sedigh fails to disclose using BrF₃ as a vapor etchant

Tai discloses a method for etching comprises the step of etching silicon using BrF₃ (col 3, lines 10-15)

One skilled in the art at the time the invention was made would have found it obvious to substitute Buskirk, Donohoe and Sedigh xenon difluoride vapor etchant with BrF₃ as per Tai because Tai discloses that BrF₃ has higher etching efficiency than that of xenon difluoride and BrF₃ is also cost effective when compared with the use of xenon difluoride (col 3, lines 5-10)

4. Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Buskirk et al (US 2002/0011463 A1) in view of Donohue et al (US 6,784,108) and Sedigh et al (US 6,893,974) and further in view of Zhang et al (US 6,162,585)

Buskirk as modified by Donohoe and Sedigh has been described above. Unlike the instant claimed invention as per claim 9, Buskirk, Donohoe and Sedigh fails to disclose using a vapor etchant recipe comprises of xenon difluoride instead of HF

Zhang discloses a method for etching using vapor HF (col 5, lines 39-40)

Hence, one skilled in the art at the time the invention was made would have found it obvious to modify Buskirk, Donohoe and Sedigh method by using vapor HF etching as per Zhang because Zhang discloses that the allowable duration of vapor HF etching allows deeper etch (col 5, lines 63-67)

5. Claims 13-14 are rejected under 35 U.S.C. 103(a) as being unpatentable over Buskirk et al (US 2002/0011463 A1) in view Donohue et al (US 6,784,108) and Sedigh et al (US 6,893,974) and further in view of Tai et al (US 6,436,229)

Buskirk as modified by Donohue and Sedigh has been described above. Unlike the instant claimed inventions as per claims 13-14, Buskirk, Donohoe and Sedigh fails to disclose the steps of preparing the etchant in vapor reservoir/exchange chamber and supplying the etchant through a loop that passes through the etch-chamber

Tai discloses the step of preparing the etchant in vapor reservoir 120/exchange chamber and supplying the etchant through a loop that passes through the etch-

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chamber 110 (fig. 1A)

One skilled in the art at the time the invention was made would have found it obvious to modify Buskirk, Donohue and Sedigh method by adding the step of preparing the etchant in vapor reservoir/exchange chamber and supplying the etchant through a loop that passes through the etch-chamber as conventional known in the art as taught by Tai

6. Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Buskirk et al (US 2002/0011463 A) in view of Donohue et al (US 6,784,108) and Sedigh et al (US 6,893,974) and further in view of Chinn et al (US 6,666,979)

Buskirk as modified by Donohue and Sedigh method has been described above. Unlike the instant claimed invention as per claim 16, Buskirk, Donohoe and Sedigh fails to disclose coating the microstructure with a SAM

Chinn discloses a method for dry etch comprises the step of coating the microstructure with a SAM (col 11, lines 18-45)

Hence, one skilled in the art at the time the invention was made would have found it obvious to modify Buskirk, Dohonoe and Sedigh method by coating the microstructure with a SAM to prevent stiction during handling (col 11, lines 16-19)

7. Claims 18-21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Buskirk et al (US 200210011463 A1) in view Donohue et al (US 6,784,108) and Sedigh et al (US 6,893,974) and futher in view of Han et al (US 6,740,247)

Buskirk as modified by Donohoe and Sedigh has been described above. Unlike the

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instant claimed inventions as per claims 18-21, Buskirk, Donohoe and Sedigh fails to disclose that the diluent gas has a partial pressure from 20-700 Torr

Han discloses a method for HF vapor cleaning/etching comprises the step using a nitrogen/diluent gas has a partial pressure from 10-500 Torr (col 7, lines 55-57)

One skilled in the art at the time the invention was made would have found it obvious to modify Buskirk, Donohoe and Sedigh method by using a nitrogen/diluent gas has a partial pressure of 10-500 Torr to enable stabilization of the operating chamber pressure as taught by Han (col 7, lines 55-58)

7. Claims 28-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Buskirk et al (US 200210011463 A1) in view of Donohue et al (US 6,784,108) and Sedigh et al (US 6,893,974) and further in view of Chen et al (US 6,159,851)

Buskirk as modified by Donohoe and Sedigh has been described above. Unlike the instant claimed invention as per claims 28-29, Buskirk, Donohoe and Sedigh fails to disclose that the structural material comprises a elemental metal and a metal nitride
Chen discloses a method for forming a semiconductor device comprises the step of forming a TiN layer with a primary conductive layer (col 6, lines 4-6)

Thus, one skilled in the art at the time the invention was made would have found it obvious to modify Buskirk, Donohoe and Sedigh method by forming a metal nitride as per Chen because Chen discloses that the TiN provides conformal adherent coating on a lower metal (col 5, lines 14-16)

8. Claims 63-64, 66, 68-69, 70-71 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lebouitz et al (US 2002/0033229A1) in view of Sedigh et al (US 6,893,974)

Lebouitz discloses a method for etching semiconductor sample/microstructure. The method comprises the steps of: collecting a plurality of data of flow rate/concentration of the etchantJ parameter during a first etching for first series of sample/first microstructure using an spontaneous vapor phase etchant recipe of xenon difluoride, determining a variation profile of the parameter in the first etch process (col 6, paragraph 0054). Lebouitz also discloses producing an etch by-product (col 6, paragraph 0052). Unlike the instant claimed invention as per claim 63, Lebouitz fails to specifically disclose the step of etching a second microstructure in a second etching process using the etchant recipe based on the collected data of the parameter in the first etching process and adapting said second etching process based on monitoring said parameter during said second etch process

Sedigh discloses etching a subsequent topography/second microstructure in a second etching process using the etchant recipe based on the collected data of the etching parameter in the first etching process and adapting said second etching process based on monitoring said parameter during said second etch process_(col 5, lines 45-49, col 24, lines 24-43, fig. 9)

One skilled in the art at the time the invention was made would have found it obvious to modify Lebouitz method to include the steps of etching a subsequent

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topography/second microstructure in a second etching process using the etchant recipe based on the collected data of the etching parameter in the first etching process and adapting said second etching process based on monitoring said parameter during said second etch process in order to refine the amount by which the etching parameters are adjusted for a subsequent semiconductor topography and to achieve minimum deviation of the post-etch values (col 24, lines 30-41)

The limitations of claims 64, 66 have been discussed above

Regarding claims 70-71, Lebouitz discloses introducing nitrogen/diluent into the chamber (col 4, paragraph 0038)

12. Claim 67 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lebouitz et al (US 2002/0033229A1) in view Sedigh et al (US 6,893,974) and further in view of Tai et al (US 6,436,229)

Lebouitz as modified by Sedigh has been described above. Unlike the instant claimed invention as per claim 67, Lebouitz and Sedigh fail to disclose using BrF₃ as a vapor etchant

Tai discloses a method for etching comprises the step of etching silicon using BrF₃ (col 3, lines 10-15)

One skilled in the art at the time the invention was made would have found it obvious to substitute Lebouitz and Sedigh xenon difluoride vapor etchant with BrF₃ as per Tai because Tai discloses that BrF₃ has higher etching efficiency than that of xenon

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difluoride and BrF₃ is also cost effective when compared with the use of xenon difluoride (col 3, lines 5-10)

Allowable Subject Matter

13. Claims 81-83 allowed.

The following is an examiner's statement of reasons for allowance: Regarding claim 81, the cited prior art of record fails to disclose or suggest a process for processing a microstructure comprises a limitation of "wherein the chemical species is an etch product" in combination with the rest of the limitation of claim 81. Regarding claim 82, the cited prior art of record fails to disclose or suggest a process for processing a microstructure comprises a step of repeating the foregoing steps until the measurement of the amount of the chemical species indicates etch rate or an initial surface area is equal to or below 1% of an initial etch rate or an initial surface area, " in combination with the rest of the limitation of claim 82. Regarding claim 83, the cited prior art of record fails to disclose or suggest a process for processing a microstructure comprises a limitation of "wherein the step of providing the additional amount of the etchant is performed when a change of the measured amount of the chemical species over time is beyond a predetermined value indicating 20% of an initial etch rate or an initial surface area", in combination with the rest of the limitation of claim 83

14. THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Conclusion

15. Any inquiry concerning this communication or earlier communications from the examiner should be directed to LAN VINH whose telephone number is (571)272-1471. The examiner can normally be reached on M-F 8:30-5:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on 571 272 1465. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Lan Vinh/
Primary Examiner, Art Unit 1792